

CLAIMS

What is claimed is:

1. A method for preparing an article of iron base metal alloyed with an alloying element, comprising the steps of

 providing a chemically reducible nonmetallic base-metal precursor compound of an iron base metal;

 providing a chemically reducible nonmetallic alloying-element precursor compound of an alloying element, wherein the alloying element is thermophysically melt incompatible with the iron base metal; thereafter

 mixing the base-metal precursor compound and the alloying-element precursor compound to form a compound mixture; thereafter

 chemically reducing the compound mixture to a metallic alloy, without melting the metallic alloy; and thereafter

 consolidating the metallic alloy to produce a consolidated metallic article, without melting the metallic alloy and without melting the consolidated metallic article, wherein the consolidated iron-base metallic article is a martensitic-composition steel.

2. The method of claim 1, wherein the step of providing the chemically reducible nonmetallic base-metal precursor compound includes the step of

 providing the chemically reducible nonmetallic base-metal precursor compound in a finely divided solid form, and

wherein the step of providing the chemically reducible nonmetallic alloying-element precursor compound includes the step of

 providing the chemically reducible nonmetallic alloying-element precursor compound in a finely divided solid form.

3. The method of claim 1, wherein the step of providing the chemically reducible nonmetallic base-metal precursor compound includes the step of

providing the chemically reducible nonmetallic base-metal precursor compound in a gaseous form, and

wherein the step of providing the chemically reducible nonmetallic alloying-element precursor compound includes the step of

providing a chemically reducible nonmetallic alloying-element precursor compound in a gaseous form.

4. The method of claim 1, wherein the step of providing a chemically reducible nonmetallic base-metal precursor compound includes the step of

providing a chemically reducible base-metal oxide.

5. The method of claim 1, wherein the step of providing the chemically reducible nonmetallic alloying-element precursor compound further includes the step of

providing a further alloying-element precursor compound of a further alloying element, wherein the alloying element is not thermophysically melt incompatible with the iron base metal.

6. The method of claim 1, wherein the step of providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element includes the step of

providing a chemically reducible alloying-element oxide.

7. The method of claim 1, wherein the step of chemically reducing includes the step of

chemically reducing the compound mixture by solid-phase reduction.

8. The method of claim 1, wherein the step of chemically reducing includes the step of

chemically reducing the compound mixture by fused salt electrolysis.

9. The method of claim 1, wherein the step of chemically reducing includes the step of

chemically reducing the compound mixture by vapor-phase reduction.

10. The method of claim 1, wherein the step of chemically reducing includes the step of

chemically reducing the compound mixture by contact with a liquid selected from the group consisting of a liquid alkali metal and a liquid alkaline earth metal.

11. The method of claim 1, including an additional step, after the step of consolidating, of

post-processing the consolidated metallic article.

12. The method of claim 1, including an additional step, after the step of consolidating, of

post-processing the consolidated metallic article by heat treating the consolidated metallic article to form a martensitic article.

13. The method of claim 1, including an additional step, performed prior to the completion of the step of melting and solidifying, of

producing a mixture of a metallic material and an other additive constituent.

14. A method for preparing an article made of iron base metal alloyed with an alloying element, comprising the steps of

providing a chemically reducible nonmetallic base-metal precursor compound of an iron base metal;

providing a chemically reducible nonmetallic alloying-element precursor compound of an alloying element that is thermophysically melt incompatible with the iron base metal; thereafter

mixing the base-metal precursor compound and the alloying-element precursor

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compound to form a compound mixture; thereafter

chemically reducing the compound mixture to produce a metallic alloy, without melting the metallic alloy; thereafter

consolidating the metallic alloy to produce a consolidated metallic article, without melting the metallic alloy and without melting the consolidated metallic article, wherein the consolidated iron-base metallic article is a martensitic-composition steel; and

post-processing the consolidated metallic article by heat treating the consolidated metallic article to form a martensitic article.

15. The method of claim 14, wherein the step of providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element includes the step of

providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element, wherein the alloying element has a vapor pressure of greater than about 10 times a vapor pressure of the iron base metal in a melt of the iron base metal, both measured at a melt temperature.

16. The method of claim 14, wherein the step of providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element includes the step of

providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element, wherein the alloying element has a melting point different from that of the iron base metal by more than about 400°C.

17. The method of claim 14, wherein the step of providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element includes the step of

providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element, wherein the alloying element has a density difference with the iron base metal of greater than about 0.5 gram per cubic centimeter.

18. The method of claim 14, wherein the step of providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element includes the step of

providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element, wherein the alloying element chemically reacts with the iron base metal or another element in a liquid phase to form a chemical compound including the alloying element.

19. The method of claim 14, wherein the step of providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element includes the step of

providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element, wherein the alloying element exhibits a miscibility gap with the iron base metal in the liquid phase.

20. The method of claim 14, wherein the step of providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element includes the step of

providing the chemically reducible nonmetallic alloying-element precursor compound of the alloying element, wherein the alloying element, if melted, chemically reacts with a crucible material or a melting atmosphere.

21. The method of claim 14, including an additional step, after the step of mixing and before the step of chemically reducing, of
compacting the compound mixture.

22. The method of claim 14, wherein the step of chemically reducing includes the step of

chemically reducing the compound mixture to produce the metallic alloy in the form

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of a spongy mass.

23. The method of claim 14, including an additional step, prior to the step of mixing, of

providing a chemically reducible nonmetallic alloying-element compatible precursor compound of an alloying element that is not thermophysically melt incompatible with the iron base metal, and

wherein the step of mixing includes the step of

mixing the base-metal precursor compound, the alloying-element precursor compound, and the alloying-element compatible precursor compound to form a compound mixture.